

# Reducing Manpower for a Technologically Advanced Ship

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# Overview

## Reducing Manpower on a Technologically Advanced Ship

- **Challenges**
- **“Total System” approach**
- **Enablers for success**

# Challenges Experienced - DDG 1000

- Numerous Ship System Design “Firsts”
- Highly constrained system technical and programmatic requirements
- Unprecedented concurrency and complexity

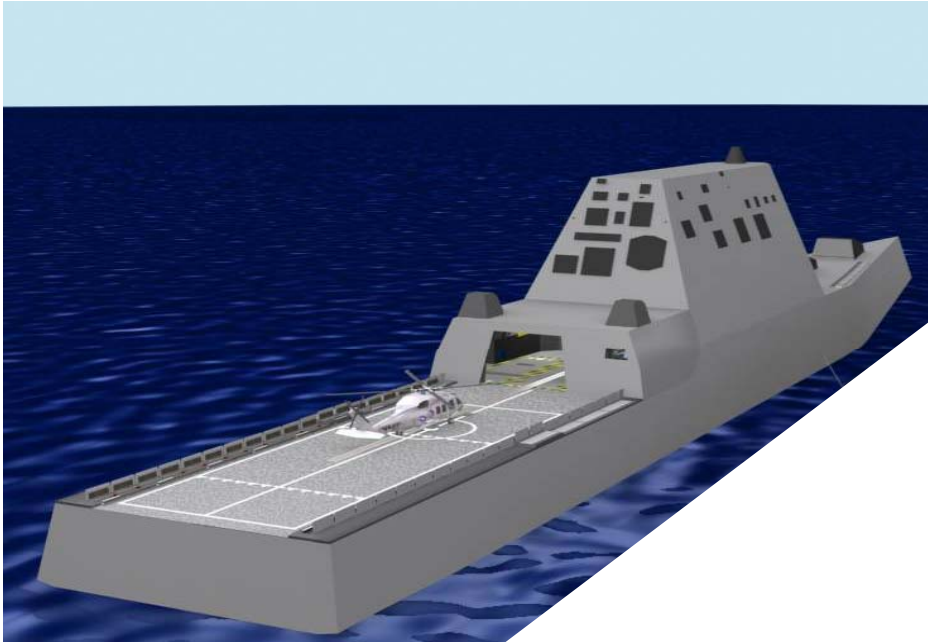


# Ship System Design “Firsts”

- A single prime contractor, leading to Critical Design Review
  - Responsible for entire ship, combat/mission system and shore support
- Ship contract design not performed by the Navy
- Ten new technologies introduced with Baseline Design
- Production planning performed directly from 3D model, not drawings
- Ship manning dramatically reduced (350+ to <150)



# DDG 1000 Requirements



## Key Performance Parameters

Net-Ready

Number of Guns

Gun Magazine Capacity

Vertical Launch Cells

Radar Cross Section

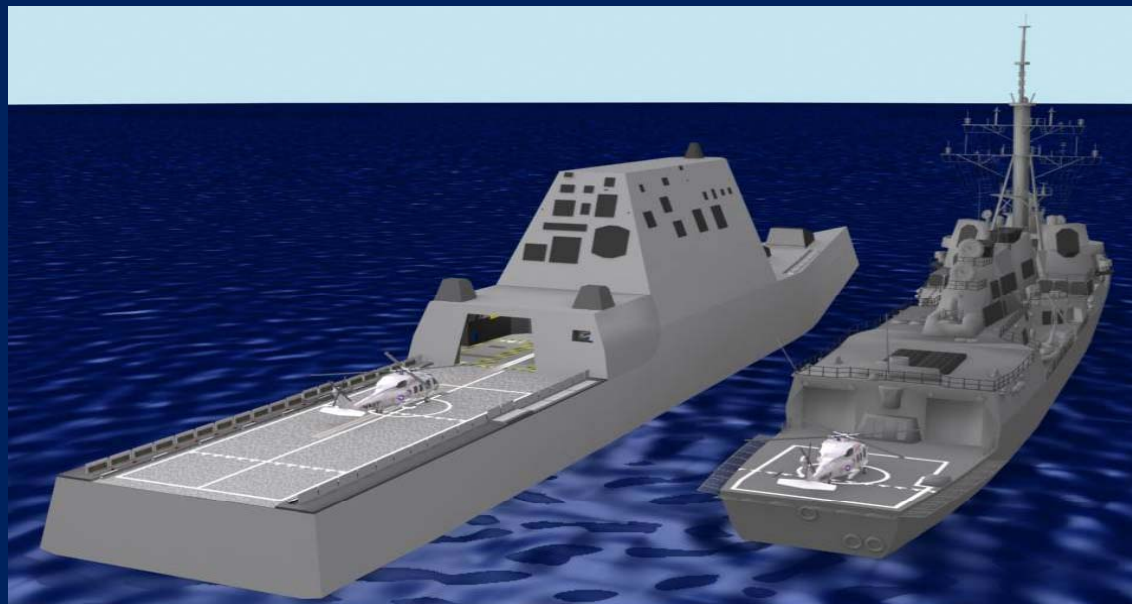
Manning

Survivability

Force Protection

- Carry the war to the enemy through offensive operations and destroy enemy targets ashore with precision strike and volume fires
- Contribute to littoral dominance: surface, air, sub-surface
- Employ an open architecture total ship computing approach
- Be highly survivable
- Reduce crew size

# DDG 1000 / DDG 51 Flight IIA Comparison



## DDG 1000

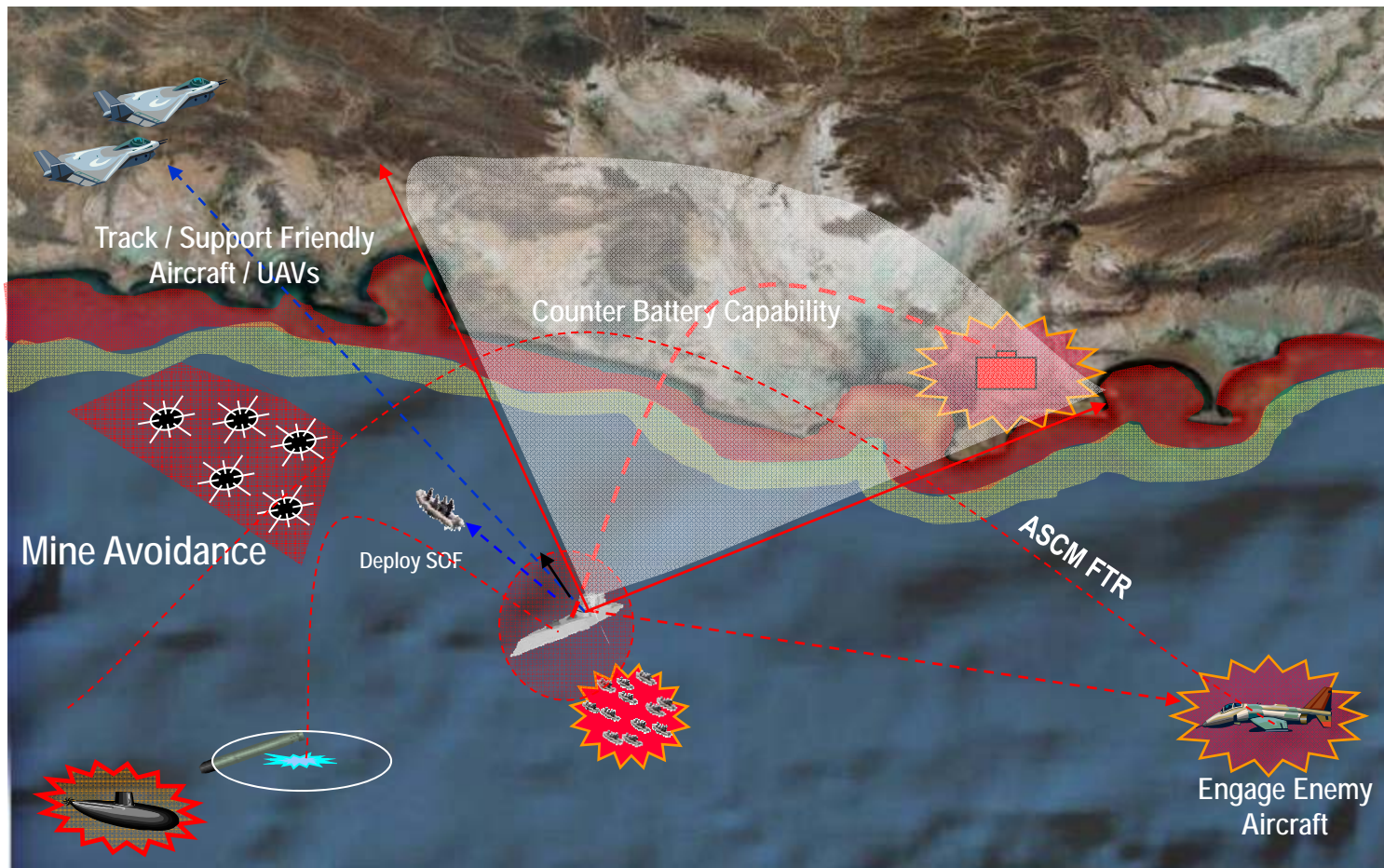
Displacement	15,105 LT
Length / Beam	600 ft / 80.7 ft
Draft	28 ft
Crew Size	148

## DDG 79

Displacement	9,217 LT
Length / Beam	509 ft / 67 ft
Draft	31 ft
Crew Size	314



# Multi-Mission Combatant



**DDG 1000 delivers capability while  
meeting Crew Size KPP**

# DDG 1000 Critical Technologies

Dual Band Radar (DBR)



Advanced Gun System (AGS)/Long Range Land Attack Projectile (LRLAP)



Composite Deckhouse & Apertures Test Article



Peripheral Vertical Launch System (PVLS) / Advanced VLS



Integrated Power System (IPS)



Autonomic Fire Suppression System (AFSS)



Total Ship Computing Environment (TSCE)

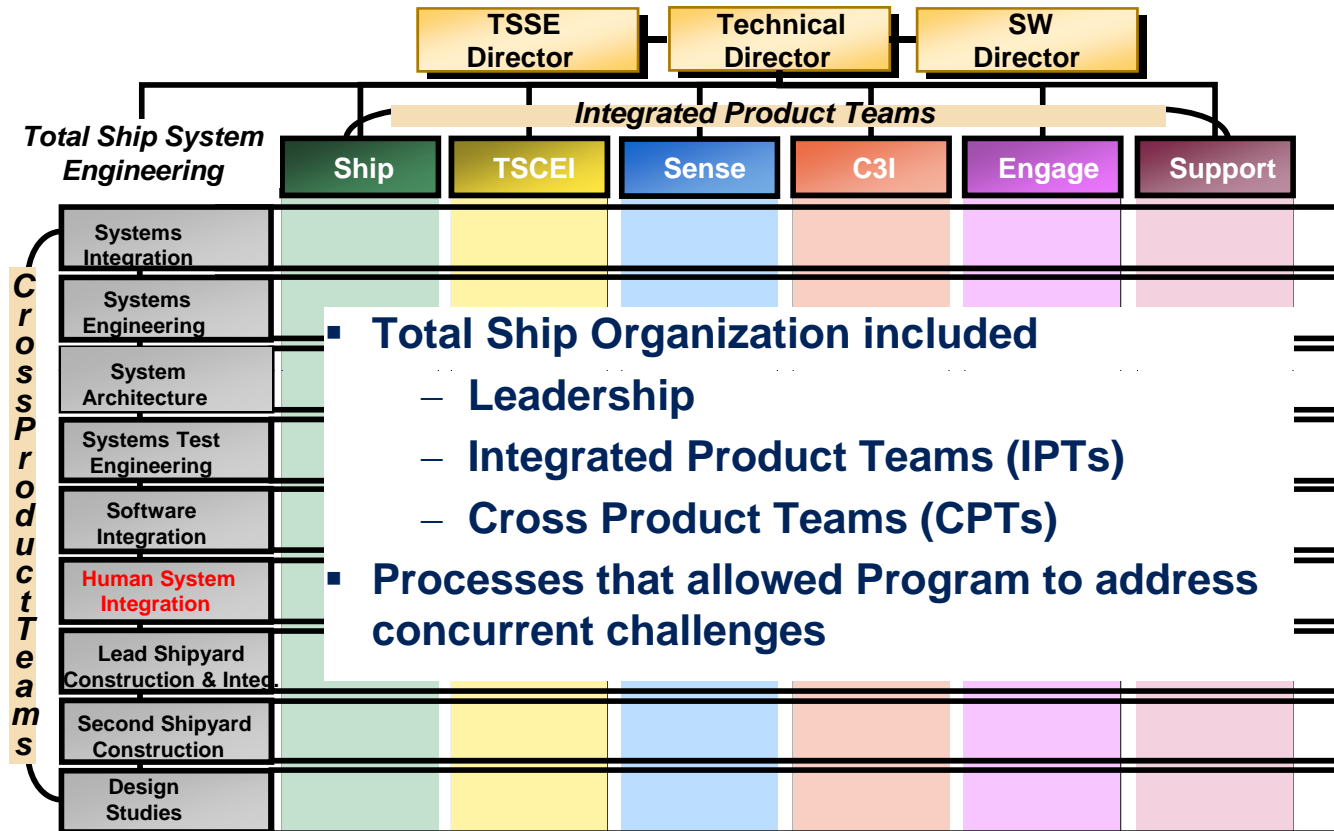


Hull Form Scale Models

Integrated Undersea Warfare (IUSW)



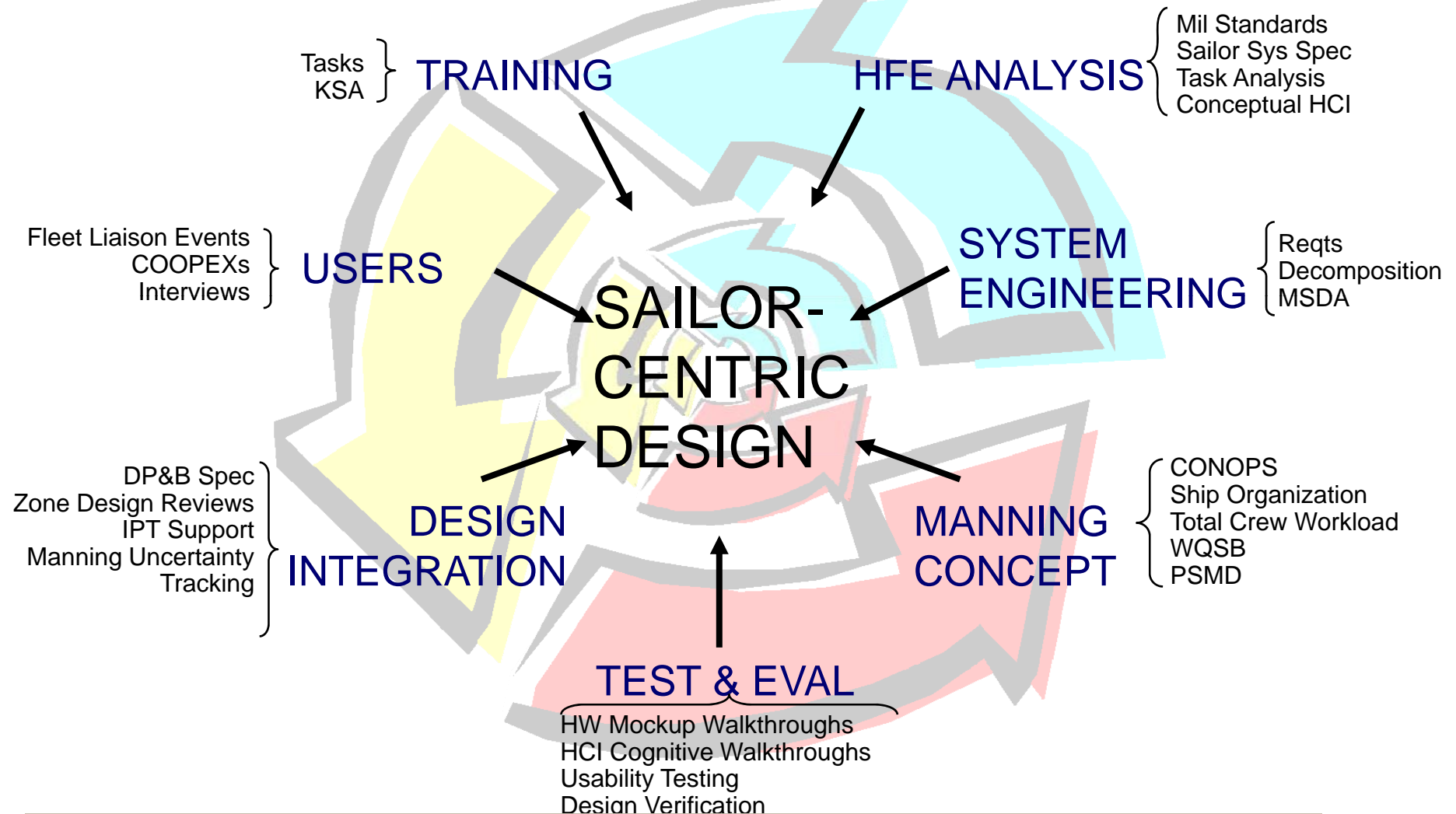
# Total Ship Organization



Program concurrency and complexity necessitated  
Total Ship System Engineering (TSSE)



# Human System Integration (HSI) Summary



**HSI is an inter-linked, repetitive process that spirals toward a sailor-centric design**

# Task Analysis Supports Crew Modeling

Days	Hours	Minutes	clock	Evolution #	Evolution Type	Num Going	Participating Crewmember Billets				
1	12	30	45000	3	ASTAC		001560				
1	13	0	46800	4	GQ Drill Brief		000020	002060	000200	000580	000680
1	13	45	49500	5	Crash Salvage Drill Brief		000680	001220			
1	15	0	54000	6	Helo Flight Quarters		001200	000760	000780	000620	000120
1	15	30	55800	9	GQ Drill		002200	001320	001340	001420	001440
1	17	30	63000	12	GQ Drill Debrf		000120	000320	000360	000400	000500
1	19	0	68400	1	OPS Brief		000020	000080	000160	001460	002060
1	19	30	70200	2	Eight Ocloc Reports		000020	000080	000160	001460	002060
2	6	30	109800	13	Man Overboard Drill Brief		000580	000040			
2	7	30	113400	14	Replenishment Brief		001600	000020	000620	001100	000140

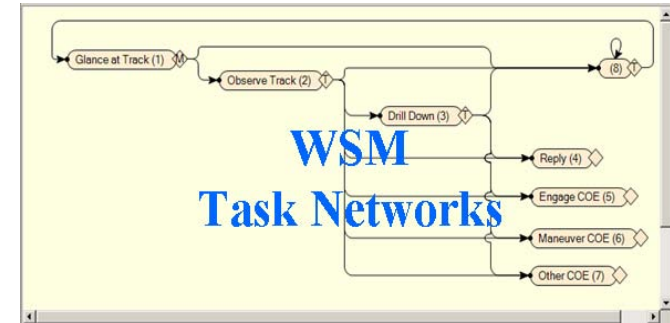
## Total Crew Model

- Crew Workload
- Crew Rest
- Crew Fatigue
- Evolution Success
- Represents WQSB

TASK_NUM	TASK_NAME	WORKLOAD_CATTASK_CATTASK_TYPTASK_DESC
19	Receive Order to create a call for action - Operational Manning / Casualty AGS Mission	Identify The operator receives a call for action leading to by determining if the voice is an authentic source act.
23	Communicate with offboard assets to verify information	Operational Manning / Casualty Communicate The operator communicates with offboard assets mission and complete the Call for Action Mission.
25	Authenticate CFA message	Operational Manning / Casualty Assess The L&W-C verifies that the information in the C...

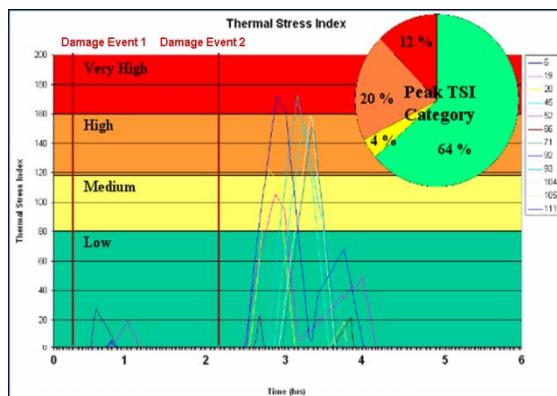
## Task Repository

- Task ID
- Timing Requirements
- VCAP



## Watchstander Model

- Watchstander Workload
- Measures of Performance
- Task Completion



## DC Manning Model

- Thermal Stress
- Workload Drivers
- DC Manning Concept

## UNREP Manning Model

- Transfer Rates
- Evolution duration
- Bottlenecks

UNREP Scenario Parameters

Transfer Rates

Gallons of DFM to transfer: Gallons of DFM per minute:

Gallons of JPS to transfer: Gallons of JPS per minute:

Gallons of Water to transfer: Gallons of Water per minute:

Cargo Replenishment

Number of AGS Ammo Containers to transfer:

Number of SIB Containers to transfer:

Number of Pallets to transfer:

Number of Retrograde Containers to transfer to CLF Ship:

Vertical Replenishment

Number of AGS Ammo Containers to transfer:

Number of SIB Containers to transfer:

Number of Pallets to transfer:

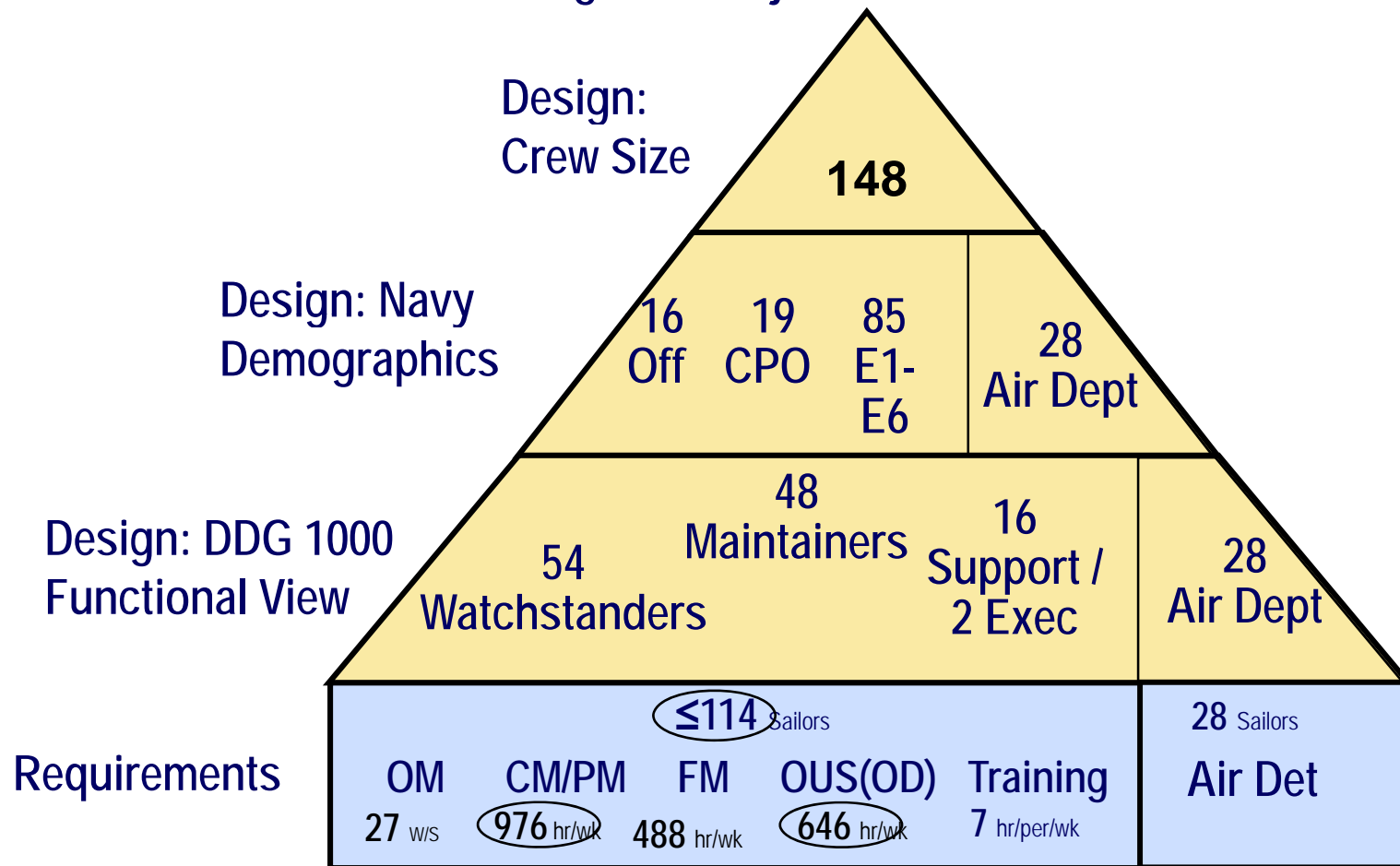
Number of Retrograde Containers to transfer to CLF Ship:

Number of Retrograde Containers per load:

OK

# Workload and Watchstation Requirements

Manning KPP: Objective 125 – Threshold 175



# DDG 1000 IUSW Watch Stander Approach



Undersea Warfare  
Specialist 1



Sea Combat  
Coordinator



Undersea Warfare  
Specialist 2

## Enabling Technology

- Alert driven Active and ISMA operations
- Remote control of MFTA depth changes
  - Manual deployment to and retrieval from 150' cable scope
- Intuitive display design to improve workflow process
- Fusion at IUSW sensor and combat system level

Search → Detect, Classify, Locate → Engage



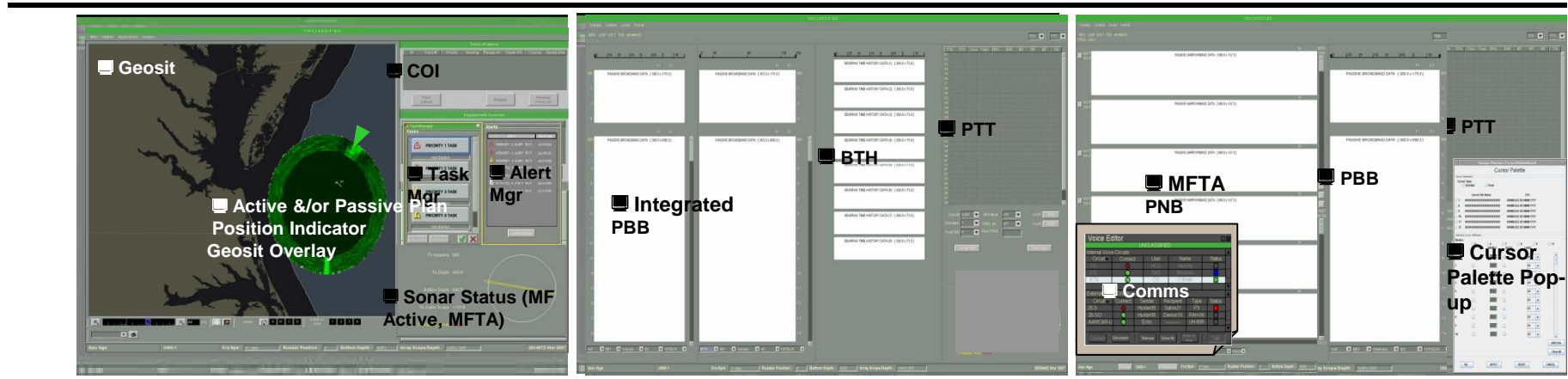
Focus shifts to  
follow the threat

Focuses on  
maintaining  
situational  
awareness, plus  
threat evaluation /  
prosecution

Focus remains on  
searching for  
new/additional  
threats

**DDG 1000 w/ 5 Crew vs. DDG 51 w/ 10 Crew  
for Condition III ASW and Mine Avoidance**

# User Centric Human Computer Interface



- Efficient use of three displays on multi-modal workstation
  - Multiple security domains deployed to single workstation
- Break down sensor → processing → display “stovepipes” at the workstation
- Deliver all screens required by IUSW watchstander to complete his/her tasks
  - Acoustic drilldown, system management, communications, situation awareness
- Conduct frequent assessments with active Fleet participants
  - Feed recommendations back into design



# Condition III Operational Manning

Flt IIA SMD Watchstations		DDG 1000 Watchstations	
Bridge	5	Bridge	2
CIC	26	Ship Mission Center	16
Eng Spaces	8	Eng Spaces	0
CSMC	6	CSMC	0
Radio/LAN	4	Radio	0
Total	49	Total	18

## Supporting Analysis

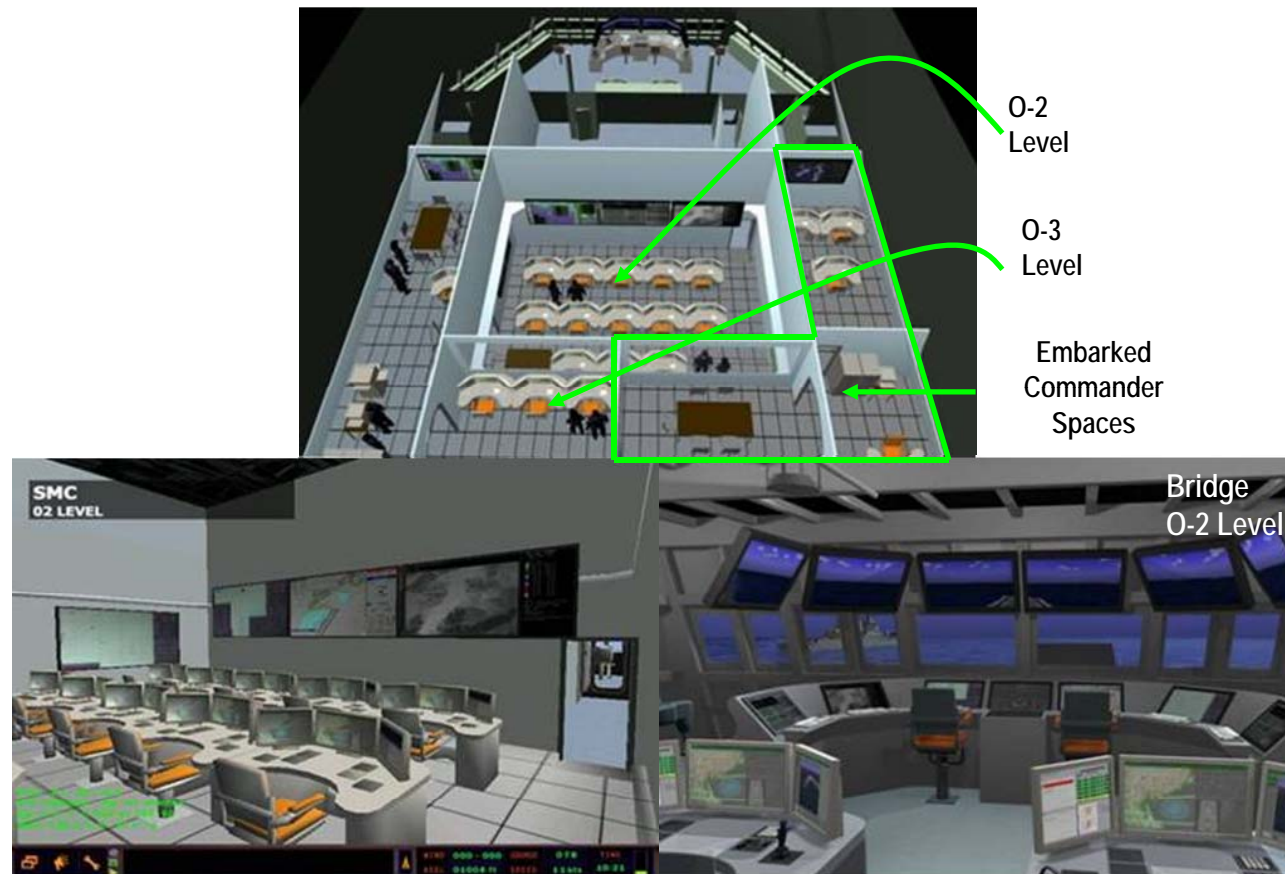
- Mission System Design Analysis (MSDA) and Task Analysis
- HSI Crew Design Gap Analyses
- Watchstander Model (WSM)
- Usability Engineering
  - Bridge and SMC COOPEXs
  - Watch Station HCI UT
- SCI SMC Assessment

## Enabling Design Features

- User-Centered Human Computer Interface (HCI)
- TSCEI – Common processors and network
  - Single operating system
  - Common Display System
  - Extensive Virtual Presence
- Automation in Readiness Assessment
  - Remote monitor / control of HME
  - Extensive Virtual Presence
  - Mission Readiness Support System (MRSS)
- Equipment Health Monitoring
- Advanced Sensor Suites

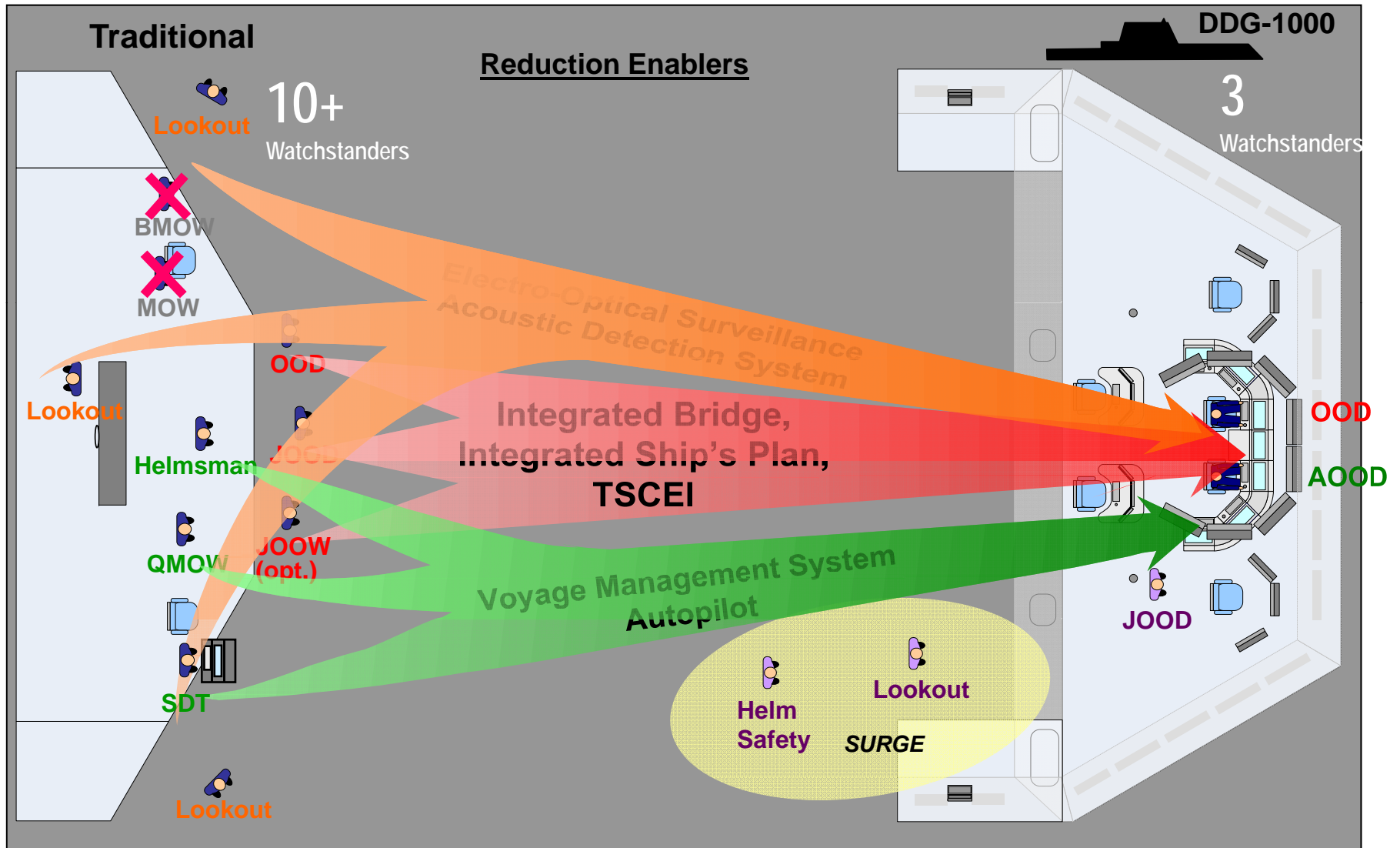
**Reduced Condition III Watchstations by 67% (49 to 18)**

# Ship's Mission Center / Integrated Bridge



**DDG 1000 Operates w/ 18 Crew vs. DDG 51 w/ 54 Crew for Condition III**

# Bridge Operations - Watchstanders





# Special Evolutions – Simultaneous VERTREP, CONREP, FAS

Flt IIA Watchstations		DDG 1000 Watchstations	
CONREP (1 Station)	28	CONREP (1 Station)	6
FAS (1 Station)	28	FAS (1 Station)	6
Strikedown	120	Strikedown	12
VERTREP	27	VERTREP	8
Engineering	7	Engineering	2
Total	* 210	Total	* 34

\*Includes Firefighting

## Supporting Analysis

- Special evolution studies
- Aviation and SIB fleet liaison events
- UNREP Discrete event model (DTB1-110)
- Total Crew Model (DTA1-110, DTB1-110)

## Enabling Design Features

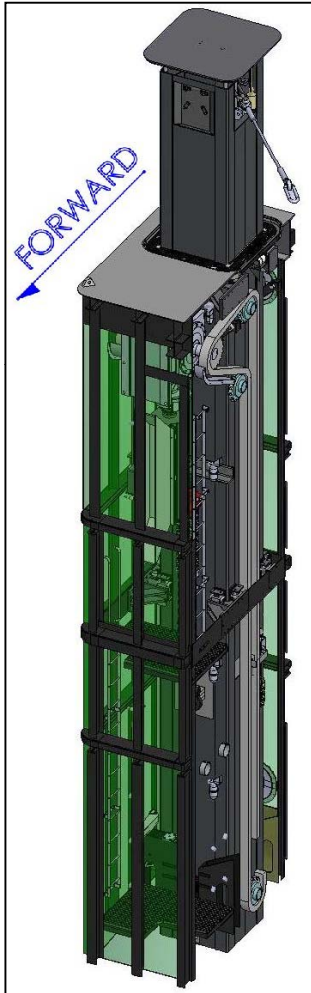
- Retractable Sliding King Post
- Anchor handling system
- Single point wireless communication
- Optimized use of RFID and Asset Management System
- Forklift transport
- High resolution surveillance
- Cargo handling passageway
- AGS handling system

VERTREP = Vertical Replenishment  
CONREP = Connected Replenishment  
FAS = Fueling at Sea

**Reduced Special Evolutions Watchstations by 84% (210 to 34 )**

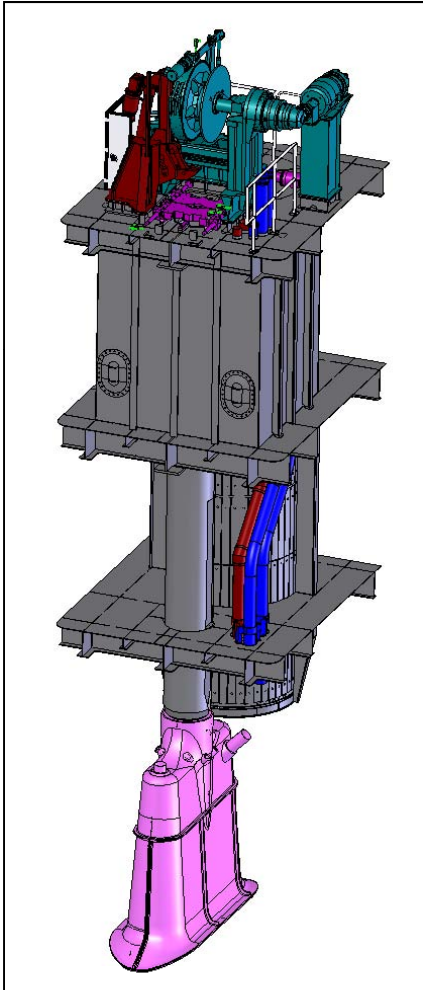
**APL**

# Retractable Sliding King Post



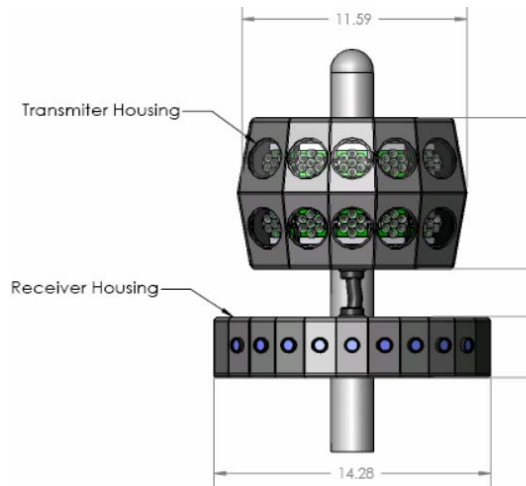
- Provides a higher sea-state-control of the load as it is being lowered to the deck by retracting the kingpost with each load transferred
  - Allows more load control with fewer personnel
- Taller than existing kingposts
  - Allows for greater clearances throughout a greater range of off-station angles
- Utilizes electric motor that raises and lowers the kingpost structure using chains and sprockets
  - Contributes to greater and more precise load control as the load clears the ship's deck edge
- All rigging attachments mounted to the kingpost and not to surrounding deck and house structure

# Anchor Handling System (AHS)

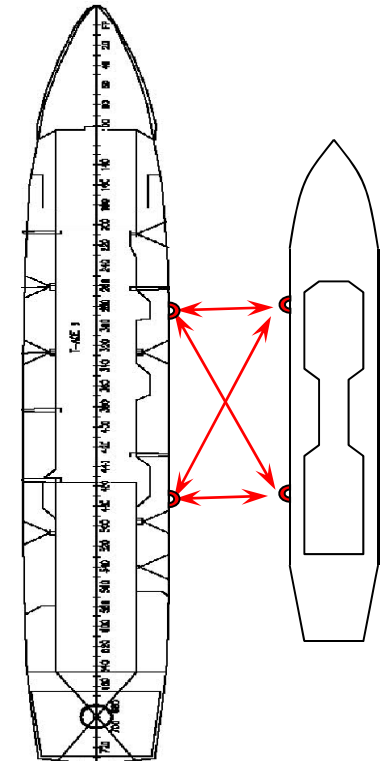


- Contains all functions of traditional anchor handling system
- Electrically driven
- Wash down system of nozzles cleans anchor and chain as it enters the AHS
- AHS control station minimizes manning
- Modular design for “drop in” installation

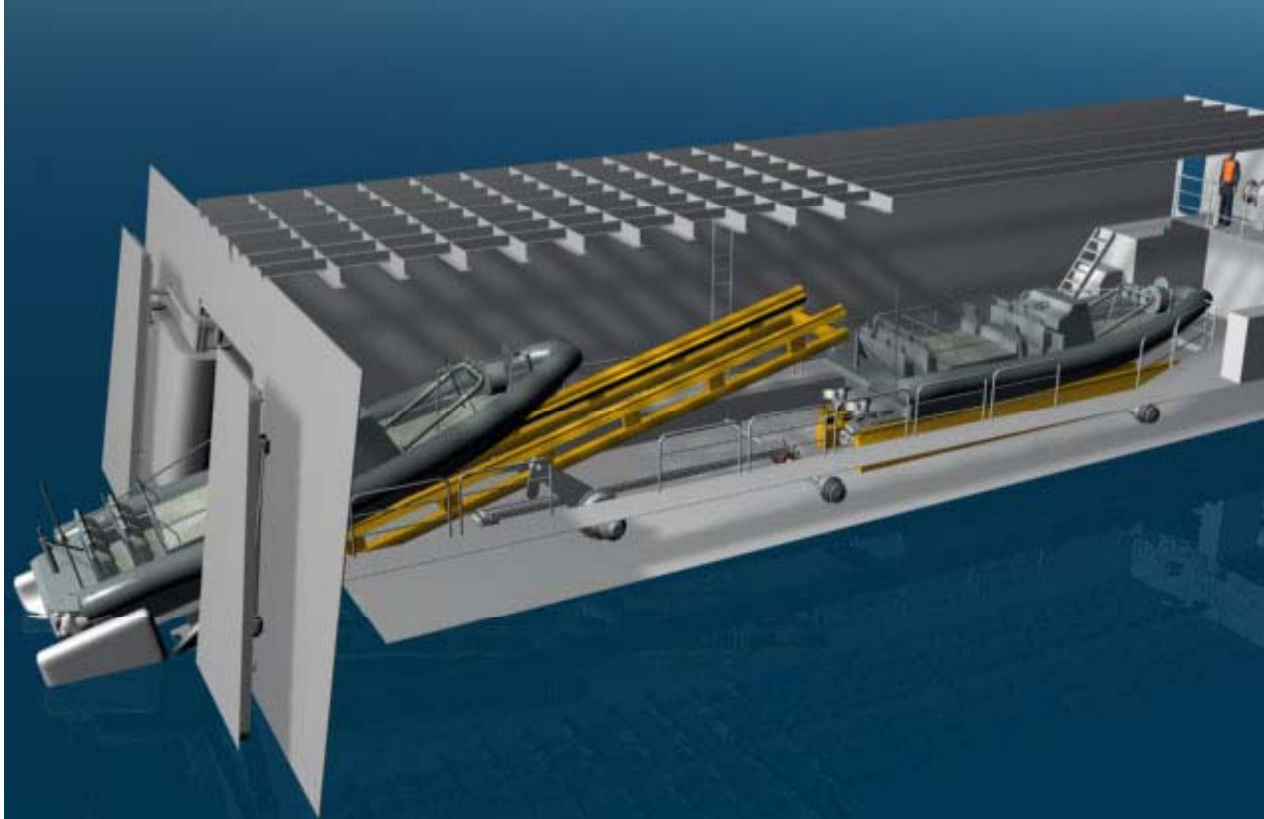
# Phone and Distance Line Replacement



- **6-PAQ transceiver units**
  - Use eye-safe IR LED Free Space Optics (FSO)
  - Transmit and receive signals over a horizontal range of 180 degrees and a vertical range of 120 degrees
  - Range provides 500+ feet ship separation
- **Multiple transceivers on each ship**
  - Redundant communications paths
  - Accuracy of a few inches



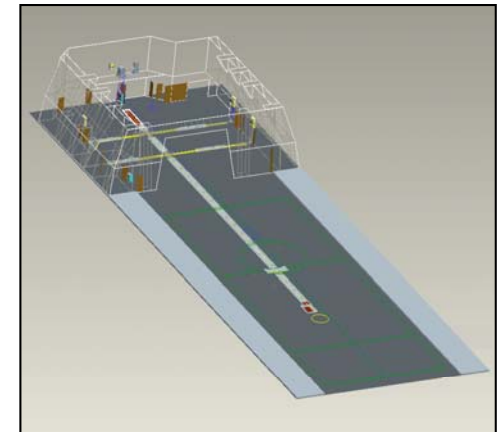
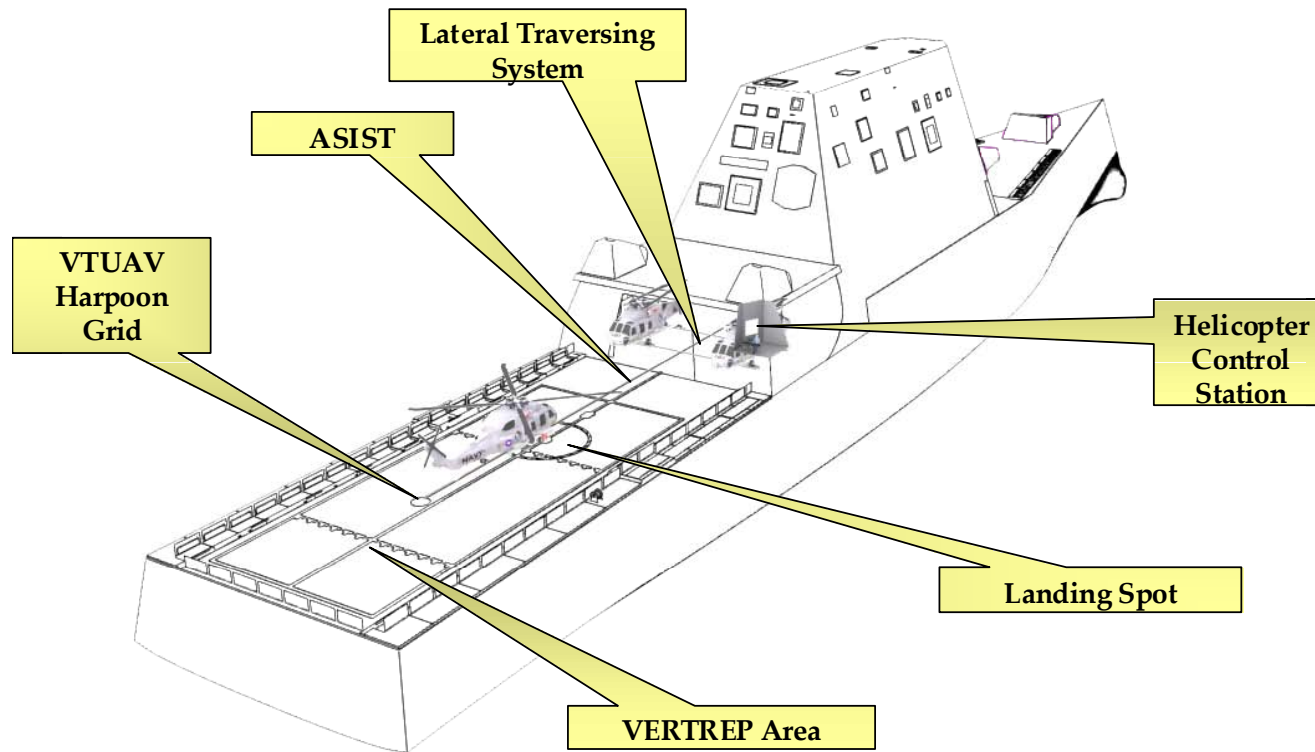
# Boat Handling System



- **Stern launch and retrieval system**
  - Launch/retrieve through sea state 5
  - Capabilities for three RHIB variants, two 11m RHIBs, and one 7m RHIB (space reservation)
- **Extendable ramp is buoyant and will match wave action angle**
  - Provide smooth transition into boat bay with relative 10 kts RHIB speed

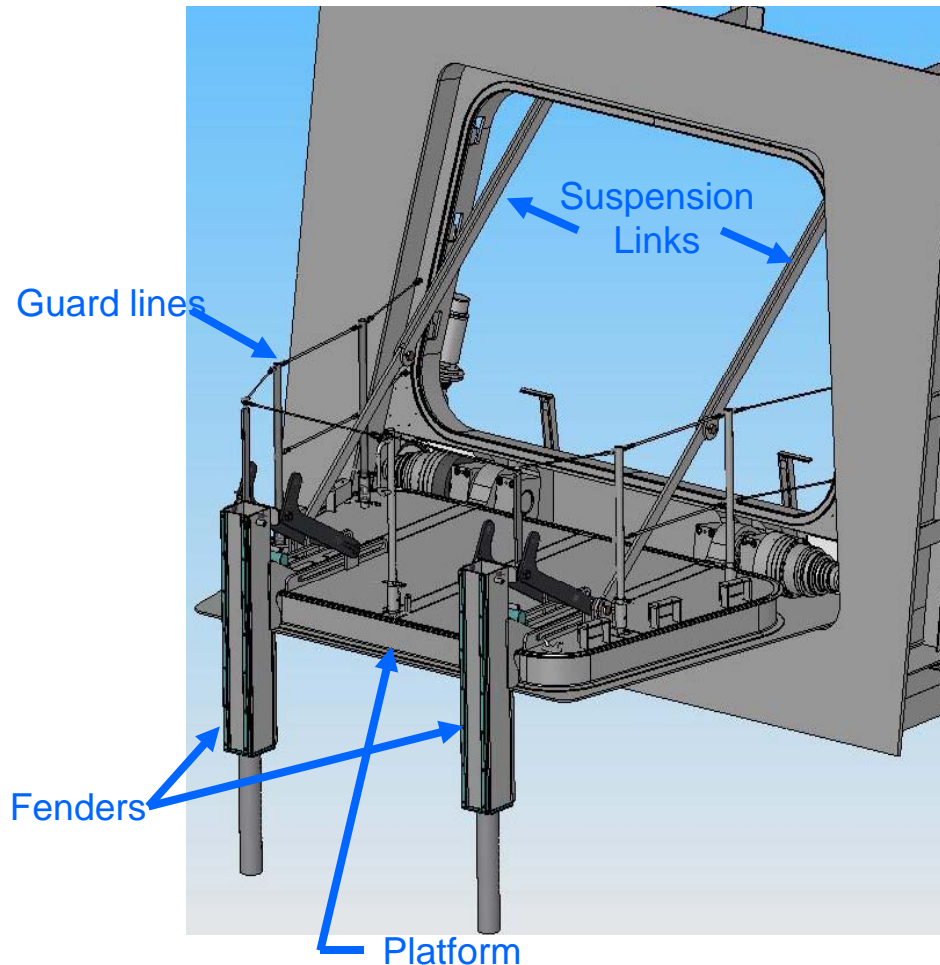


# Aircraft Handling and Securing System (AHSS)



- Integrated system that remotely
  - Captures aircraft (A/C)
  - Guides A/C to the deck,
  - Translates A/C into the hangar,
  - Moves A/C laterally inside hangar to stowage position

# Embarkation Platform



- Machinery is electrically operated and weather tight, requiring low maintenance
- Delivered with guard lines that provide personnel protection
- Allows operations through sea state 3 with fendering feature

# Damage Control

Flt IIA SMD Watchstations		DDG 1000 Watchstations	
Condition I	119	Condition I	85
Condition II*	48+	Condition II	42
Condition III*	11	Condition III	7**

\*Estimated, not in SMD

\*\* Initial Rapid Response Team (RRT)

## Supporting Analysis

- DC ARM (98-01)
- USS SHADWELL AFSS EDM Tests
- DT event ATG Norfolk (Fleet Review)
- SWOS Newport DCA School Review
- Fleet/ATG SME Review
- Missile/Mine Hit CCOEs
- DTB1-110 DC Manning Model

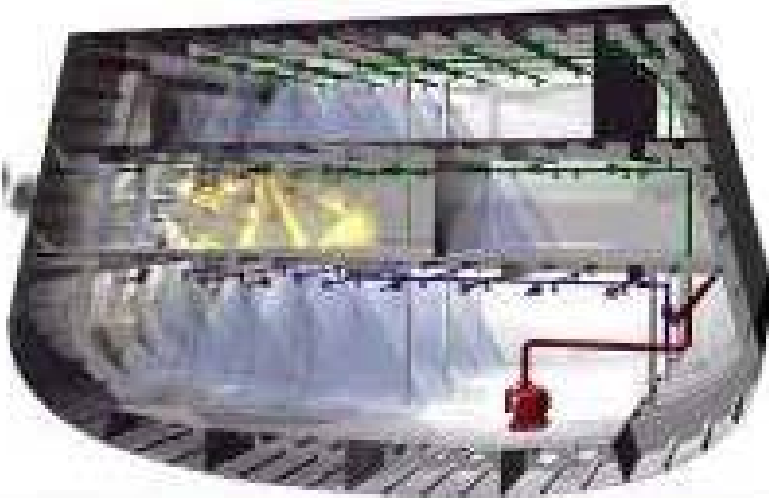
## Enabling Design Features

- Autonomic Fire Suppression System (AFSS)
- Smart valves – isolation
- Advanced sensor suites
- Virtual presence
- Personnel locating system
- TSCEI communications
- Damage decision and assessment
- Automated de-watering
- Maximum vulnerability control
  - Zones: Fire protection, electrical, CPS
  - Smoke control

**Reduced DC Condition I Watchstations by 84% (119 to 34)**



# “Autonomic” Fire Suppression System



- AFSS is designed to automatically:
  - (1) Isolate damage to firemain piping components,
  - (2) Detect fire, smoke and heat conditions,
  - (3) Activate suppression systems and
  - (4) Suppress fires using a variety of suppression systems including water mist for suppressing peacetime machinery space fires and combat induced fires and sprinkling for magazines



TeleroBotic Fire Nozzle (TFN)



Spot/ Smoke Heat



Optical Flame Detector



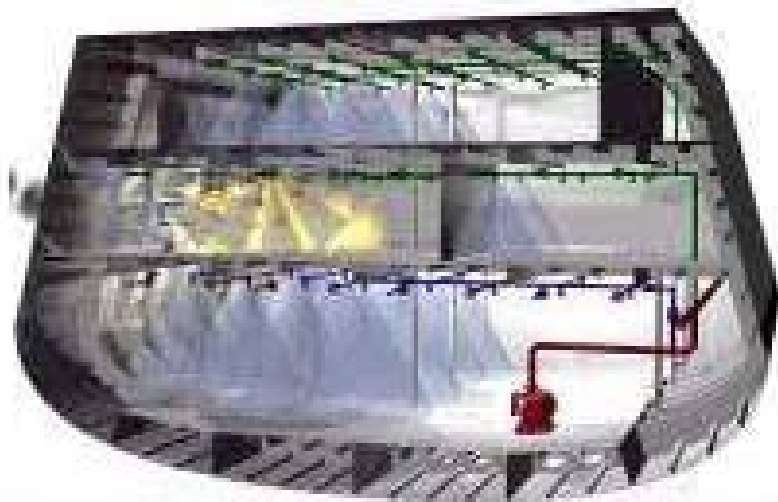
Linear Heat Detector



Smoke Aspiration

**DDG-1000 Fire Detection Sensors**

# “Autonomic” Fire Suppression System



Ex-PETERSON Warhead Explosion

# CM / PM Workload

Flt IIA SMD Hr/Wk On-Board		DDG 1000 Hr/wk On-Board	
Operators	476	Operators	20
Maintainers	1350	Maintainers	864.5
Support	76	Support	4
Total *	1902	Total **	888.5

\* Includes (15%) Make Ready Put Away (MRPA)

# WSTR request CM / PM WL Allocation Increase to ~ 1080 m-hr/wk

## Supporting Analysis

- **Supportability Workload and Reliability, Maintainability, & Availability (RMA)**
  - **Analysis of alternatives**
  - **Top 10 Driver Reduction**
  - **Knowledge, Skills and Abilities (KSA) focused task analysis for targeted equipment**
  - **Crew Design Gap Analysis (DMS, SC, SA Support)**
- **Enabling Design Features**
  - **Condition Based Maintenance (CBM)**
  - **Comprehensive equipment health monitoring**
  - **Increased equipment reliability**
  - **Lowest Replaceable Unit (black box replacement)**
  - **On-demand training support**
  - **Shore support**
  - **Automated magazine monitoring**
  - **Automated Identification Technology (AIT)**

**Reduced CM / PM Workload by 53% (1902 to 889)**

# Facilities Maintenance (FM) Workload

Flt IIA SMD Hr/Wk On-Board		DDG 1000 Hr/Wk On-Board	
Operators	343	Operators	33
Maintainers	199	Maintainers	274
Support	564	Support	135
Ship Total	1106	Ship Total	442
Shore	0	Shore	395
Total	1106	Total	837

## Supporting Analysis

- **Compartment-level workload analysis by HSI CPT**
- **Advanced tool assessment**
- **KSAs determined for tasks**
- **Appropriate detail throughout the Design Build Specification**

## Enabling Design Features

- **CBM**
- **Reduced hydraulics**
- **Material Selection**
  - Improved deck coatings
  - Corrosion resistant coatings
  - Corrosion resistant fasteners
- **General Arrangements**
  - Improved air filtration
  - Freshwater flushing
- **Shore Support**
  - Augment for all preservation
  - Augment for periodic deep cleaning
- **Enhanced / Advanced tools**
  - HEPA filter type vacuum
  - Disposable toilet wands
  - “Grease cutting” spray / wipes
  - “Enhanced personal responsibility” training

**Reduced Facilities Maintenance hrs/wk by 60% (1106 to 442)**

# Own Unit Support (OUS)

Flt IIA Manning		DDG 1000 Manning	
CS/FSA	24	CS/FSA	9
SK	9	SK	2
SH	5	SH	2
YN/PN	5	YN/PN	1
HM	3	HM	1
DK/PC/NC	3	DK/PC/NC	0
Total	49	Total	13

## Supporting Analysis

- Food service discrete event model
- Food service fleet liaison events
- Smart ship galley data collection
- Food service task evaluation
- Shipboard evaluations of OUS tasks and workload (DDG 89, 91, CG 53)

## Enabling Design Features

- **Advanced food service system-approach**
  - Centralized galley
  - Streamlined Inventory Control / Automated provisions access
  - Advanced pre-prepared foods
  - Advanced Equipment Suite
  - No FSA but specific evolution / space cleaning assist.
- Streamlined (flexible-delivery) personal services concepts
- Automated Information Technology (AIT)
- Advanced telemedicine

**Reduced Own Unit Support Crew by 73% (49 to 13)**

# Training

Per 1000.16J Hr/wk/Billet		DDG 1000 Hr/wk/Billet	
Training	7	Accounted for by OM or Other Work	6.73
		Not Accounted for by OM or Other Work	5.01
Total	7	Total (Average)	11.74

## Supporting Analysis

- Fully assessed surface force training manual and SORM for all exercises and courses
- Training categories analyzed
  - Proficiency Training (PT), Cross Training (CT), Team Training (TT), Exercise Hours, Course Hours, Administrative Training, Training Administration, Physical Readiness Training (PRT)
- Variations of training analysis
  - Deployed (sustaining quals)
  - Inter deployment period (attaining qualifications and team forming, etc.)

## Enabling Design Features

- CBM
- Library multimedia center
- Automated electronic learning classroom
- Enhanced team training
- Secondary Ship's Mission Center (SSMC)
- SMC Briefing / Debriefing Room
- Learner Model
- Adaptive Training
- Integrated Training System
- Integrated Learning Environment
- Homeport Training Facilities

# Summary

## Reducing Manpower on a Technologically Advanced Ship

- **Challenges**
  - Requirements, acquisition approach, CAIV, ...
  - Culture acceptance of deviations from current policies
- **“Total System” approach**
  - Commitment to a rigorous sailor-centric process throughout engineering and development
- **Enablers for success**
  - Workload task analyses that support a Total Crew Model
  - Design decisions that considered manning
  - Application of technologies